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Vol.

1. 3 numbers, 1928.
2. 4 ,, 1929.
4. 4 ,, 1931.
5. 2 ,, 1932.
6. 2 ,, 1933.
7. 1 number, 1934.
8. 4 numbers, 1935-37 (None of Nos. 2 and 4).
9. 4 numbers, 1938 (None of No. 2).
10. 4 ,, 1939 (None of No. 4).
12. 4 ,, 1941 (None of Nos. 1 and 2).
13. 4 numbers, 1942.
14. 4 ,, 1943.
15. 4 ,, 1944.

ISSUES OF THE AGRICULTURAL CIRCULAR.

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Vol. 1, 1920, 12 numbers.
,, 2, 1921, 5 ,,
,, 3, 1922, 4 ,,
Vol. 4, 1923, 1 number.
,, 5, 1924–5, 2 numbers.

As number 4 of Vol. 3 was printed as " Volume 4 " and number 1 of Vol. 4 as " Volume 5 " it would appear from an inspection of a complete set that Volume 4 comprised only a number 4 and that there were two issues of Volume 5, Part 1.

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—EDITOR.

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AGRICULTURAL JOURNAL

ISSUED BY THE

DEPARTMENT OF AGRICULTURE, FIJI.

VOL. 16.] JUNE, 1945. [NO. 2

EDITORIAL.

WEEDS.

IN this issue we publish an article by the Agricultural Officer Southern on the control of weeds in pastures. This provides the opportunity to refer to the deterioration of pastures and estate lands which has occurred as the unavoidable result of the shortage of farm labour during the war period, and of the preoccupation with food crop production and other wartime controls of the staff of the Department of Agriculture, which is charged with the responsibility for the enforcement of weed control measures. In 1944 Government appointed a committee to report on the present weed position in the Colony and to make recommendations for its amelioration. The committee has not yet reported, but without anticipating the report it will be obvious to all concerned with agriculture, and particularly with stock husbandry, that as soon as conditions permit a determined effort must be made to recover lost ground. Weeds are no new problem to the farmer in Fiji, in fact perhaps the most troublesome have been with us for many years and some of these are present in all parts of the Colony. However, others are as yet restricted in their distribution, though spreading each year and spoiling yet more land, and an attempt must be made to limit or at least delay their rate of spread, while it is also necessary to discover the most economical methods of control on lands already infested.

Unfortunately weed control enforcement is not simply a matter of the authorities proclaiming as a noxious weed, and ordering the destruction of, undesirable plants, to be followed by automatic action by occupiers of land ; if it were so there would be no problem for there is no more effective way with the individual weed than pulling or grubbing it out by the roots, without looking for weedicides, weed-burners or other mechanical aids. The hard fact is that expenditure on weed control must be related to the return received from the land, or at least the potential return, and the authorities must be reasonably sure that the cost of eradication or control is within the bounds of economic possibility before requiring action to be taken by occupiers of land. This is the limiting factor in any country, and its application in this Colony brings us face to face with the fact that with the exception of the cane farms and some dairy farms, farming in Fiji is as yet largely in the extensive phase with a comparatively low return per acre. Moreover, these settled areas are often widely separated from each other by large tracts of undeveloped and sparsely inhabited land, the domain of semi-wild cattle which

are active agents in the spread and encouragement of weeds ; except for Fijian gardens and Indian farms, occupying in all a small proportion of the total area, such land is unproductive and would carry little or no expense of weed eradication or control. Neither would the expenditure of large sums of money by Government on the eradication of weeds on unoccupied land be justified, for ultimately the cost would fall on farmers in the form of increased taxation. There is at least this benefit to be derived from some of the weeds of pastoral areas : they preserve the land against unrestricted exploitation and irremediable spoilation by over-stocking, and preserve it until progressive settlement and increasing land values justify expenditure on fencing, clearing, and controlled grazing or other forms of development.

Weed control being, therefore, governed by land utilization, local policy resolves itself into a search for the most effective and economical methods of discouraging the growth of weeds on developed lands and of increasing the output per acre in order to allow of heavier expenditure being incurred on such control measures.

While experimentation on various forms of mechanical and chemical control will be necessary, one of the most effective control measures, the importance of which has been insufficiently recognized, is the indirect one of promoting the strong growth of desirable plants—the crop—and so resisting the establishment and spread of weeds. There is little doubt, for example, that the low yields obtained by many dry-land rice farmers is due to insufficient attention to the preparation of the land ; the example of a few dairy farmers also shows that by proper attention to drainage, subdivision, and the rotation of grazing, necessary expenditure on weed control can be substantially reduced by conserving and promoting the growth of pasture plants, and it is probable that top dressings would tip the balance still further against weeds. The rate of spread of weeds and the intensity of infestation of land is closely associated with livestock management. So long as cattle are allowed to roam and graze at will over extensive areas of land, so long will weeds be unmanageable, for not only do the cattle spread weed seeds in droppings, feet and hair, but uncontrolled grazing encourages weeds at the expense of grass. Fencing and weed control go hand in hand.

It is perhaps unfortunate in a sense that Fiji experienced the early and outstanding success of the almost complete control of Köster's curse by the introduced thrips, and of partial success in the biological control of *Lantana* ; this has led many people to hope that similar control may be achieved in the case of some of our other weeds. There appears to be little justification for this hope ; and, moreover, the complete eradication of any one of our present weeds would, under present conditions of land utilization and management, most likely result only in its replacement by one or other of the remaining weeds. There is no easy way of weed control ; ultimately it can be brought about only by effective land utilization and good farm management.

—C.H.

WEED CONTROL IN RELATION TO PASTURE MANAGEMENT.

By
B. E. V. PARHAM, M.A., Agricultural Officer.

"No major work of weed control can be permanently effective unless the country is at the same time efficiently grassed and farmed"—E. Bruce Levy (1).

The economic use of the grazing lands of the Colony is a matter of the greatest importance at the present time. The value of the established large-scale activities of cattle raising and dairying is well known to the readers of this *Journal* but of no less importance from a national point of view are the activities of the smallholder, running a few head of stock (working animals, milch cows, horses or goats) often as a sideline to some other form of farming. In the aggregate these latter use a very large area of land and are thus responsible for the trusteeship of a great part of the Colony's potential soil wealth. To the uncontrolled efforts of pastoralists and stock owners, large and small, may be attributed to a considerable degree the widespread deterioration of much valuable land, brought about by the spread of weeds, by soil erosion and by the destruction of natural plant cover on land unsuitable for the purpose of grazing stock.

Despite many efforts on the part of private individuals as well as of Government during the past 40 years there has, it is generally felt, been little real advance in the establishment, management and maintenance of balanced pastures. For a great many small farmers, at any rate, grass utilization has merely meant grass exploitation and destruction. Any area of para grass,* on flat or grassed slope, is fenced, stocked and grazed to extinction. In many settled areas handfeeding of stock has become necessary and this usually means the daily cutting of bundles of para grass from roadsides or stream banks outside the farm holding.

The following table shows the estimated area of land devoted to grazing (including fallow land used for part of the year) in the Southern Agricultural Division (Ra, Tailevu, Naitasiri, Rewa and Serua).

	Area in acres.	
Purpose.	*Flat.*	*Hill.*
Dairy farms	12,000	8,000
Pastoral areas	8,000	14,000
Smallholders	3,000	5,000
	23,000	27,000

Stock owners everywhere complain of the spread of weeds and the deterioration of their pastures for which, although themselves often primarily responsible, they seek a remedy.

The hard facts which are brought home to the farmer in the form of reduced yields of milk or beef, by loss in carrying capacity or by weed infestation and soil erosion are the end results of well-known processes in the ever-changing ecological † relationships between the pasture plants and the grazing animals. The infestation of pasture by weeds is, for example, a process of retrogressive succession in which the controlling factor is that of competition between the pasture and the unpalatable plant species. The processes on which the pasture and the animal depend for life and health are capable of being controlled to a large degree by attention to the principles of pasture management.

* *Brachiaria mutica* Stapf.

† Ecology treats of the relationship between the plant or animal and its environment.—*Editor, Agricultural Journal.*

It is obvious that the prospects of applying these principles in any region depend to a large extent on the type and character of the pasture and upon a knowledge of the requirements for its maintenance at an optimum level. In the briefest language the requirements may be stated to be the establishment of good pasture swards and their maintenance at a maximum level of efficient and economic production.

In most temperate countries the establishment of pasture calls for the clearing of land and the sowing of one or more species (grasses, legumes, etc.) which are of proved worth. In Fiji such a method is rarely practised and at the present time such sown pastures are limited to plantings of cuttings of para grass, to sowings of blue grass (1), with a very small area of sown *Paspalum* (2). Fiji, in common with many other tropical lands, lacks a balanced pasture sward inasmuch as legumes are conspicuous by their absence. The principal legumes in our grassed areas, sensitive plant (3) and so-called trefoil (4) often contribute very slightly to the composition of the sward, although when present they improve the quality of the pasture. Many grasses have been introduced to the Colony, in fact, the grazing areas of the Colony are all examples of artificially induced exotic plant associations. Many introductions have either failed to become established under local conditions or have not been established on a large enough scale to enable their value to be assessed.

The principal pasture grasses which have become established, several being accidental or at least unrecorded introductions, are para grass, carpet grass (5), blue grass, *Paspalum*, Thurston grass (6), *Digitaria* spp.

Inferior grasses which sometimes predominate in grazed areas are sour grass (7), seed grass (8) and mission grass (9).

Useful fodder grasses which have become well established are Guinea grass (10) and elephant grass (11). These are frequently cut and handfed to stock.

Conspicuous amongst the introduced grasses which have failed to become established are Rhodes grass (12), Kentucky blue grass (13) and perennial rye (14).

Similarly among legumes a very large number of species has been introduced but only a few of them have become sufficiently naturalized to play any great part in pasture composition. Most widespread of these are the several species of *Desmodium*, *Alysicarpus* and in one area a species of *Stylosanthes*.

The present note deals with certain aspects of weed control in relation to pasture maintenance, although it is impossible to minimize the fundamental importance of a right beginning. The main immediate practical problem, however, is that of utilizing the available grasslands to the best purpose or, in other words, maximum production of palatable fodder within the limits of practical economy. This involves the protection and encouragement of the pasture plants and the elimination of unpalatable species.

The following observations deal mainly with the question of weed control in pastures, but it will be seen that this itself is not an isolated problem but one which is often best dealt with by a combination of methods including those of rotation and manuring.

---

(1) *Dicanthium* spp.
(2) *Paspalum dilatatum* Poir.
(3) *Mimosa pudica* L.
(4) *Desmodium* spp.
(5) *Axonopus compressus*, and *A. affinis* Chase
(6) *Brachiaria distachya* A. Camus.
(7) *Paspalum conjugatum* Berg.
(8) *Raphis aciculatus* Rety.
(9) *Pennisetum polystachyon* Schult
(10) *Panicum maximum* Jacq.
(11) *Pennisetum purpureum* Schumach.
(12) *Chloris gayana* Kunth.
(13) *Poa pratensis* L.
(14) *Lolium perenne* L.

There are two important aspects of weed infestation in pastures, (*a*) the ecological relationship between the pasture plants and the weeds, and (*b*) the grazing animal in relation to the weed.

(*a*) PASTURE PLANT VERSUS WEEDS.

The composition of any plant community such as that of a pasture sward is determined by the factor of competition between the individual species making up the community. In the case of grazing or pastoral lands the degree of competition and its trends are predetermined by the density of the sward and by its utilization. As stated above, the variations in the amount of light and shade control the competition ; and the invasion of grassland by weeds (i.e. plants unpalatable to stock) is mainly due to alterations in the conditions of light and shade within the pasture complex.

Many weed seeds lie dormant in the soil and the subsoil for very long periods but, so long as the surface of the ground is shaded by the grass canopy, they do not germinate. When the grass surface is broken and light penetrates, these weed seeds germinate and, by their rapid growth, soon overtop and overshadow the pasture plants which often are so weakened that they die out.

The continued grazing of the pasture plants by stock aids this process by reducing the density and competitive vigour of the grass in its struggle with the weed. This process is commonly seen in many parts of the Colony, e.g. para grass pastures when overstocked rapidly succumb to the pereminal weeds such as *Solanum* ([15]), hibiscus burr ([16]), primrose willow ([17]), etc. and hill pastures of natural grasses or of a mixed *Paspalum* or carpet grass may rapidly give place to heavy growth of *Solanum* together with such weeds as the so-called tobacco weed ([18]), rat-tail ([19]) or guava ([20]).

The greatest danger to pasture is the formation of gaps in the grass cover as weeds at once take possession of the bare patches. Such gaps may arise from a number of causes, such as bad drainage and bad soil conditions resulting in poor growth of the sward, or, as is commonly the case, they may be the direct result of overstocking and trampling.

In the former case attention to drainage is a first consideration and liming, with or without top-dressing of fertilizer or liquid manure (yard wastes), is necessary to promote a strong growth of the pasture.

Locally, drainage is much neglected and any form of soil treatment appears to have been regarded as out of the question. As a result there are many examples of low yielding and weedy pastures where the causes of deterioration are obvious. The widespread infestation of pastures with the semi-aquatic and insectivorous tarweed ([21]), the presence of primrose willow and of many kinds of sedge are indicative of poor drainage condition. In such cases the physiological conditions are extremely adverse to the pasture plants but very favourable to the weed species.

In some of these deteriorated pastures there has been a noticeable reduction in the amount of sensitive plant present ; in some areas this species has completely disappeared. Liming (with coral sand) has resulted in the return of this legume and to a reduction in the amount of tarweed present.

([15]) *Solanum torvum* Sw.
([16]) *Urena lobata* Linn.
([17]) *Jussieua suffruticosa.*
([18]) *Elephantopus mollis.*
([19]) *Stachytarpheta urticæfolia* (Salisb.) Sims.
([20]) *Psidium guajava* L.
([21]) *Cuphea carthagenensis* (Jacq.) Macbr.

The absence of a legume from pure para grass stands appears to have a depressing effect upon the growth of the latter which is not relieved even under conditions of discontinuous grazing without either the application of nitrogenous fertilizer or ploughing and replanting. This may be due to more than one cause.

It is well known that stock fed on a balanced ration eat a smaller daily quantity of grass than those fed on grass only. The presence of legumes in pasture, therefore, tends to reduce the pressure on the other herbage present. Also the capacity of all legumes to fix atmospheric nitrogen has long been utilized as a means of increasing available nitrates for other plants. For this reason the presence of legumes in the pasture is directly beneficial to the associated grasses.

While *Mimosa* may not be a highly desirable fodder plant on account of its woody, thorny stems, it is regarded by many farmers as an important component of pastures. This view is based on the observed differences in production yields on local pastures.

The role of legumes in any attempt to establish a dense and balanced pasture sward is generally well known. Various efforts have been made in the past to introduce and acclimatize locally the common pasture legumes of other countries. Trials have been made of white and red clovers, lucerne, *lotus major* and subterranean clover, but none of these have proved able to compete successfully under local climatic conditions. More recently search has been made for tropical legumes which might be suitable for the purpose. The most promising to date is the so-called pencil grass or "Stylo" ([22]) which has been established in several localities and which is now being tried under normal grazing conditions. This plant grows luxuriantly from a central root stock. It is of low spreading habit and a single plant may cover 12 to 20 square feet of soil. It produces a heavy crop of foliage which is relished by stock, and it seeds very freely.

Another useful legume is "Centro" ([23]), which is of creeping habit and which persists well in grassland. Together with "Puero" ([24]) it is most useful for covering bare patches and preventing soil erosion. Field-scale trials of these plants are contemplated as soon as stocks of seed are sufficient for the purpose.

(*b*) THE GRAZING ANIMAL IN RELATION TO THE WEEDS.

The introduction and spread of many weeds is directly due to animals, especially the burrs ([25]) the seeds of which are carried in the hair and fur, and plants such as tarweed whose seeds are carried in mud on the feet. The control of such weeds can be partly checked by denying stock access to infested areas either on or off the farm, at least during periods when seeds are ripe, and by having burrs removed before the animals are moved to clean grazing areas.

One of the most important factors in the spread and control of weeds in pastures is the system of grazing practised ; close and continuous grazing is the most common cause of weed infestation of grazing land.

Continuous grazing introduces light to the ground surface and promotes conditions suitable for weed germination and growth ; intermittent grazing creates conditions of shade which are more favourable to the pasture plants. The various systems of rotational grazing are based on these facts.

([22]) *Stylosanthes gracilis.*
([23]) *Centrosema pubescens* Benth.
([24]) *Pueraria phaseoloides* Benth.
([25]) *Urena lobata, Sida rhombifolia, S. acuta* and *Triumfettia bartramia* are common examples.

Gaps in the pasture due to the direct action of stock are well illustrated in areas about stockyards, milking sheds or around trees where stock congregate. In such places dense stands of many weeds are to be found, e.g. tarweed, Paddy's lucerne, kaumoce and tobacco weed, growing in the bare patches produced by the trampling of the stock. It is often from such centrally placed clumps that progressive infestation of adjacent fields proceeds.

Certain grazing animals, e.g. goats and horses, may be used to control weeds which are not palatable to cattle and this method is occasionally practised locally.

It is obvious that the control of weeds in any area is more or less futile unless the land so made available is efficiently utilized for the production of crops which include, of course, pasture grasses. For this reason emphasis is placed on pasture management as the principal means of controlling weed infestation, i.e. by preventing them becoming established rather than upon the more obvious and direct methods such as biological control, use of weedicides or mechanical operations, which constitute the available means of dealing with established weeds, i.e. by curative effort.

This point may be well illustrated by reference to a local example. As is well known the weed Köster's curse was formerly the principal weed of pastures in the wet zone areas. This plant was brought under control most effectively during the years 1930-33 by the introduction of the parasitic insect, *Liothrips urichi*, and it has ceased to be regarded as a major pest in this Agricultural Division.

Farming practice, however, does not appear to have been sufficiently effective to take full advantage of this achievement with the result that the weeds *Solanum* and hibiscus burr succeeded *Clidemia* as the major weeds, and more recently tobacco weed threatens to become a major pest in the same pasture areas. In recent years labour conditions have intervened on the side of the weeds and in many areas the retrogression has reached such a stage that the clearing of weeds has become the most pressing problem facing the dairy farmer and stock owner.

Recommendations.

The following notes summarize the recommendations which, in the light of local experience, can be made for dealing with the problem by attention to (*a*) the pasture plant, (*b*) the grazing animal and (*c*) the weed.

(*a*) THE PASTURE PLANT.

1. The following grasses have been proved satisfactory in pastures under controlled grazing systems : para grass, carpet grasses (*Axonopus affinis*, *A. compressum*), blue grasses (*Dicanthium* spp.), *Paspalum* (*P. dilatatum*).

Reasonably well managed, these species are capable of standing for long periods with a sufficiently dense cover to minimize weed infestation. Para grass is, of course, most suitable for flat land, but must not be over grazed ; the blue grasses (especially *Dicanthium* species and *Ischæmum aristotum*) are most promising and form a close cover on hill country to the exclusion of the usual perennial weeds, and when heavily grazed these species form an excellent turf. *Paspalum*, to be weed-resistant, requires much attention, especially with regard to drainage, and under local conditions appears to suffer from the absence of a suitable leguminous symbiont.*

* A symbiont is one of two mutually beneficial partners, e.g. the root-nodule bacteria and the legume.—*Editor.*

2. Leguminous plants of established reputation in local pastures are the sensitive plant, the so-called trefoils, and also *Alysicarpus vaginalis*. To these may be added the recently-introduced pencil grass, *Centrosema pubescens*, *Calopogonium mucunoides* and *Pueraria phaseoloides*, which are thoroughly acclimatized and which flourish under local conditions. The last three show promise for use as smother plants ; they are widespreading creepers capable of over-growing shrubby plants and are all very palatable to stock.

3. Fodder plants of established worth are elephant grass and Guinea grass ; the latter is capable of withstanding weed infestation.

4. Top-dressing of pastures with phosphates and lime to improve the growth of the grasses is rarely practised locally, and until investigations are undertaken it is impossible to indicate optimum rates and times of application.

The work of Fawcett and others in New Zealand as recorded by Hamilton (2) has established the close association between adequate top-dressing, high carrying capacity, and high production per acre, but it is stressed that production may be maintained with quite small dressings of phosphate. The total quantity of minerals sold off the farm is not large. Assuming a production of 150 lb. of butterfat per acre (average 4.5 per cent test) the amount removed in the milk per annum is equivalent to only 41 lb. of superphosphate, 26 lb. of 30 per cent potash salts and 10 lb. of ground limestone. Where home separation is practised the major portion of these minerals remains in the skim milk and part might be conserved and returned to the pastures.

Topdressing with lime and phosphates is mainly an indirect method of supplying nitrogen to the pasture through the medium of legumes, in the absence of which early response to topdressing is often poor.

Hamilton also refers to recent and important work on the influence of animal wastes on the pasture. It has been found that, on high-producing pasture, in the first season the animals returned to the soil in the course of normal grazing the equivalent of 15 cwt. sulphate of ammonia, 6 cwt. superphosphate, 8.75 cwt. of 30 per cent potash salts and 2.25 cwt. of ground lime. Four hundredweight of phosphate to the acre had been applied at the time of sowing, and in the first year more than this amount was returned to the pasture via the animals.

These results emphasize the value of good legume growth in the maintenance of pasture sward, with a minimum of topdressing.

(*b*) THE GRAZING ANIMAL.

1. Avoid overstocking for prolonged periods.

2. Practise rotational grazing. This may be done by subdividing the grazing area into a number of small paddocks which are grazed in rotation for short periods and spelled for longer periods ; alternatively, three paddocks may be grazed in rotation for periods up to 10 days, leaving a minimum of 20 days for recovery.

For large herds this calls for a considerable area of para grass (approximately three head per acre) and most dairy farmers prefer to use the former method, although it frequently results in excessive trampling and heavy destruction of grass foliage. The aim in grazing para grass should be to retain a cover not less than 6 to 9 inches in depth, grazing off young growth when it has reached 18 inches in height. The general aim of rotational grazing is to prevent weed infestation resulting from damage to the pasture by ringing the changes, so that the grass canopy is nowhere broken, and the ground surface thus remains shaded.

3. Prevent stock from wandering into weed-infested areas. This involves attention to fencing and avoidance of the practice of taking stock out to graze along roadsides.

4. In order to prevent undue pressure on limited grazing areas during periods of grass shortage, hand feed the stock, bed them down with a layer of grass trash, and make compost for application to pasture areas.

5. Use horses to graze weeds such as hibiscus burr, blue rat-tail and *Sida*, and goats for guava. This is an economic and effective method of weed control and results in a reduction of the spread of weeds by preventing them from flowering.

(*c*) THE WEED.

All perennial weed species should be cut down, rooted up or otherwise destroyed before the seed matures. In the case of hibiscus burr and *Solanum*, the best time for this is the month of May, and certainly the work should be completed by the end of June. The latter weed is liable to grow again from the crown or from roots and for this reason it is better to cut it down than to grub it out, leaving small parts of the root in the ground. If stumps shoot, the young growth should be knocked off during the ensuing three weeks. This treatment usually kills the plant completely. Following the main weeding, all young plants of both these weeds should be pulled up as a regular routine. Tobacco weed is difficult to eradicate and should be rooted up when in the young stages or cut down before seed matures in order to prevent widespread infestation. Seed is carried on the wind and spread is usually downwind.

Guava is most persistent in some areas where propagation from root shoots is most prolific. Until chemical sprays are fully investigated, cutting down periodically appears to be the only practical method of dealing with this weed. In some areas goats should be employed to keep the growth in check. In clearing land infested with large guava it is sound practice to cut the trees down two or three feet above ground and to remove the shoots as they appear. This depletes the food reserves in the root system. As with *Solanum*, attempting to grub out guava often results in widespread growth of root shoots which are difficult to eradicate without unduly disturbing the soil surface and grass cover.

In the case of such weeds as Paddy's lucerne, blue rat-tail, hibiscus burr, etc. which often first appear in limited clumps about stockyards, early rooting up is essential.

Mowing is strongly recommended for pastures suitably situated as it helps control most of the weed species in the early stages of growth and also to renovate the pasture plants. Mowing, to be effective, must be regular and not too close to the ground. It is especially valuable for the control of the smaller weeds such as the sedges, tarweed, goatweed, etc.

Hoeing and grubbing weeds in grassland is regarded as the most efficient means of dealing with established weeds and is the method best suited to the small farmer. It does not, however, prevent the germination of seed already in the ground and must be accompanied by improvement in the grass cover.

Weed-burners and weedicides have obvious advantages, but their use locally has not been widely adopted. Chemicals for weed control are usually, (*a*) contact sprays to destroy foliage, as for example sulphuric acid, dilute chlorates and arsenical sprays ; (*b*) penetrating sprays, which destroy plant tissues and also penetrate slowly into the root system ; (*c*) temporary soil-sterilizers, as common salt or sodium chlorate used often in the dry state to eradicate

limited patches of serious weeds ; and (*d*) permanent soil sterilizers which kill seedlings and render the soil sterile for long periods. These latter are used mainly along roads and drains.

Of the above mentioned weedicides, sodium chlorate has been used locally with good effect on such weeds as *Solanum*. It is usually preferred to the arsenical solutions and is regaded as non-poisonous to stock when applied to weeds in dilute solution. It is, however, dangerous to stock in the dry state or in solution and on account of its inflammable nature must be handled with great care.

For foliage-spraying the recommended strength is ½ lb. to ten gallons and the rate of application is 100 gallons per acre for lesser infestations and up to 200 gallons per acre for heavy growth. For deep-rooted weeds a strong solution, 1 lb. to one gallon, is normally used and in some cases a second treatment is applied two or three weeks later with a stronger solution, viz. 1½ to 2 lb. per gallon.

Salt is a valuable weed-killer and especially useful for application to isolated plants and small patches.

Finally, reference must be made to the control of bad infestations of weeds on grasslands by closing the areas and excluding all grazing animals for extended periods. This permits the recovery of grasses and also the growth of other plants, such as mile-a-minute, which smother the weed growth very effectively. Observations in the field suggest this as a means of dealing with some of the extensive areas of native land which have become so heavily infested with burr and *Solanum* as to be no longer capable of carrying stock.

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THE HIDDEN EROSION.

THE first enemy of the African soil is the rain which causes erosion. If 60 inches of water is poured on to the soil within a few weeks it pours off, takes the soil with it and throws it into the sea. All West African rivers are muddy as they are carrying Africa into the ocean.

I am not sure that the next enemy is not the consumer who carries away the produce of the soil and does not bring anything back. By shipping the produce of a country overseas strange things can be done to the constitution of the soil. Even in America they are learning that the dust bowl may have something to do with the Liverpool grain market.

The peasant knows a great deal about agriculture and he has a lot of inherited knowledge. He knows the deep-rooting trees, the bush which bores down into the hard soil and brings up the constituents that are necessary for plants and are bottled in the trunks of the trees and vegetation. He cuts them down and burns them and carries out what is called "shifting cultivation."

I saw a place which had been highly commended by modern science where something like shifting agriculture was being experimented with because it was found that that was the only way in which the soil could be rejuvenated. If the process of "bush fallow" cultivation is pushed too hardly and a sufficient opportunity for rejuvenation of the soil is not afforded, the second soil erosion will be scarcely less devastating than the first.

—*United Empire*, Vol. 35, No. 6, Nov.-Dec., 1944. (COL. WALTER ELLIOT).

AN ANNOTATED CHECK LIST OF THE MEALY BUGS AND SCALE INSECTS OF FIJI.

By
R. J. A. W. LEVER, B.Sc., D.I.C., A.I.C.T.A., F.L.S., Entomologist.

THE flat or tent-like scale insects and the white, fluffy mealy bugs are only too well known to gardeners whether they occur as chaff-like scales on citrus fruits and rose stems or as white waxy clusters on avocado or rose leaves.

The first paper (1) on local Coccidæ was published in 1915 and dealt with only a dozen species. More recently, in reviewing this family in Samoa, Laing (2) gave the total number of species from Fiji as only 27 so that the need for this local check list is at once apparent though it is realized that the present total of 51 is far from complete. Another reason for this revision is that several well-known pests, having been known for many years by familiar names, have had these changed so that it is often difficult to recognize them under their new guise.

The four papers published by Messrs. Veitch and Greenwood (3-6) between 1921 and 1940 record the names of most of the economic insects and form an invaluable summary of the early records which have been drawn upon in this article.

I.

The first subfamily, Monophlebinæ or giant Coccids, is well represented by the non-endemic genus *Icerya*, the well-known cottony cushion scale, a large, rotund insect.

1. *Icerya purchasi* Mask. A very wide range of plants of which citrus, guava, mango, *Crotalaria*, *Cassia*, *Casuarina* and *Inocarpus* (ivi) are perhaps the most common.

2. *I. seychellarum* Westw. This pan-tropical "mealy bug" is only too prevalent on citrus, coffee, tea, breadfruit, guava, avocado, raspberry, rose, teak, *Mimosa pudica* (sensitive plant) and chilly (*Capsicum*).

3. *Palæococcus rosæ* Ril. and How. on roses.

II.

The Dactylopiinæ or true mealy bugs have, as in I, profuse secretions of wax but are of an elongated oval shape. This subfamily includes many serious pests of leaves, shoots, fruits and even roots.

4. *Pseudococcus brevipes* Ckll. is common on pineapple leaves and sugar-cane stalks; it was formerly referred to as *P. bromeliae* Bouché. Causes pineapple wilt.

5. *P. citri* Risso, the citrus mealy bug but also found on cocoa pods, wild fig, *Clidemia hirta*, *Inocarpus* and custard apple.

6. *P. vitiensis* Green and Laing from leaves of coconut and royal palm (*Oreodoxa*). Specimens from coconut were found in 1940 to be parasitized by a new Scelionid parasite, *Nasdia prosper* Nixon (7).

7. *P. comstocki* Kuw. occurs on *Pandanus* (screw pine) leaves.

8. *P. longispinosus* T. T. recorded from flowers of the orchid *Calanthe veratifolia* (8).

9. *P. cocotis* Mask. on coconut leaves.

10. *Ferrisiana virgata* Ckll. common on *Poinsettia* leaves, also on cotton, coffee, lantana and custard apple. Formerly *Pseudococcus*.

11. *Phenacoccus* sp. from *Pandanus* leaves.

12. *Asterolecanium bambusae* Boisd. on stems of bamboo, *Schizostachyum glaucifolium*.

13. *A. miliaris-longum* Green on bamboo leaves. This genus has glassy threads of wax and is sometimes separated into a distinct subfamily.

III.

The Coccinæ or soft scales are usually of seed-like appearance and are of considerable economic importance. They include the well-known cochineal insect.

14. *Coccus hesperidum* L. the soft brown scale found on orange, lemon, mandarin and coconut in Fiji but recorded from pawpaw in Samoa (2).

15. *C. viride* Green on guava, coffee and *Ixora*. Formerly *Lecanium viridis*.

16. *Lecanium elongatus* Sign. on avocado pear and candle nut (*Aleurites*). One of the tortoise scales.

17. *Saissetia coffeæ* Walk., the hemispherical scale. Occurs on maidenhair fern (*Adiantum*) and the ornamental *Graptophyllum*. Likely to be taken on lemon as recorded from this tree in the New Hebrides (2). Formerly *S. hemispherica* Targ.

18. *S. nigra* Nietn. Of the many plants attacked cotton, *Hibiscus rosa-sinensis*, *Sida retusa*, *Basella alba*, guava, canna and the burr *Xanthium italicum* are the most important.

19. *Vinsonia stellifera* Westw. on mango, fig and *Calophyllum inophyllum* (dilo).

20. *Ceroplastes rubens* Mask. is one of the wax scales and has been taken from citrus, mango, pigeon pea and *Barringtonia speciosa* (vuturakaraka).

21. *Pulvinaria floccifera* Westw. on teak and chilly leaves.

22. *P. psidii* Mask. on lemon but, as the name shows, it was first taken on guava.

23. *Eucalymnatus tesselatus* Sign. on *Calophyllum* (dilo) but from cinnamon and *Morinda* in Samoa (2).

IV.

Finally we come to the so-called armoured or hard scales, Diaspinæ, among which many of the most serious pests occur as their tough cuticle tends to resist spraying and so they require frequent treatment, thus adding to the cost of control.

24. *Aspidiotus destructor* Sign. is the Bourbon or transparent scale which, until its control by ladybirds, was a serious pest in the Colony. Its life history and biological control have been studied thoroughly by Dr. Taylor who includes (8) a full list of its food-plants supplied by Paine, among the chief of which are coconut, banana, guava, mango, pawpaw and yam. There is a variety known as *transparens* Green.

25. *A. cocotis* Newst. also on coconut.

26. *A. excisus* Green. on skins of banana. First recorded from Ceylon.

27. *A. cyanophylli* Sign. on banana, coconut, guava and rubber.

28. *A. pangoensis* Doane and Ferris. Husk and leaf-base of coconut.

29. *A. simmondsi* Green and Laing. Coconut leaf-bases.

30. *A. suvaensis* Green. Stem and leaves of mangrove (*Rhizophora mangle*).

31. *Aonidiella aurantii* Mask., the Californian red scale found on stems, leaves and fruit of citrus and banana. Formerly *Aspidiotus* and *Chrysomphalus*. Said by Simmonds in 1938 to occur only in the New Hebrides (9), but recorded from Fiji in 1921 (3).

32. *Aspidiella hartii* Ckll. found on yam tubers. Once called *Aspidiotus*.

33. *Chrysomphalus dictyospermi* Morg., the Spanish red scale on banana, coconut bark and wild ginger ; once *Aspidiotus*.

34. *Hemiberlesia lataniæ* Sign. Banana and grapefruit. Formerly *Aspidiotus*.

35. *H. palmæ* Ckll. Dalo (*Colocasia*), breadfruit, coconut and banana.

36. *Aulacaspis* sp. near *cinnamomi* Newst. The common scale of rose stems, formerly referred to as *A. rosæ* Sanberg (3) but said by Dr. W. J. Hall not to be this well-known species.

37. *Chionaspis dubia* Mask. on maiden-hair fern (*Adiantum*).

38. *Phenacaspis samoana* Doane and Haddon on palm. Formerly *Chionaspis*.

39. *Leucaspis cockerelli* de Charm. Found by Quarantine Department, Hawaii, in 1940, on an orchid *Spathoglottis* from Fiji.

40. *Odonaspis penicillata* found by U.S. Quarantine at Washington in 1939 on a bamboo from Fiji.

41. *Pseudaulacaspis pentagona* Targ. the West Indian mulberry scale. Found on stems of blue-rat tail (*Stachytarpheta urticæfolia*), hibiscus burr (*Urena lobata*), mulberry, almond and *Hibiscus esculentus* (bindi). Formerly *Diaspis*.

42. *Diaspis bromeliæ* Kerner on pineapple.

43. *Fiorinia proboscidaria* Green. Orange and lemon leaves and rose stem.

44. *Lepidosaphes tokionis* Kuwara, a common scale on "croton" (*Codiæum*) leaves. Formerly referred to as *L. auriculata* Green or *L. lasianthi* Green.

45. *L. gloverii* Pack. On lemon leaves in Fiji. On croton and orange in Samoa (2).

46. *L. beckii* Newm., the purple or mussel scale. On leaves and stalk of orange, lemon and grapefruit. One of the most important citrus insect pests in the world.

47. *Pinnaspis aspidistræ* Sign., the aspidistra scale. Occurs on leaves of coconut, banana and orange.

48. *P. buxi* Bouché. On coconut leaves.

49. *P. minor* Mask. On cotton, coconut leaves, banana, yams, *Inocarpus* (ivi) and Eucharist lily. Formerly *Hemichionaspis*.

50. *Unaspis* (*Prontaspis*) *citri* Comst., the orange or snowy-white scale on fruit and leaves of lemon, mandarin, orange, grapefruit and pumelo. Some uncertainty still exists about the name which is also given as *Chionaspis yanonensis* Kuw. but the name used above is more generally employed.

51. *Dinaspis veitchi* Green and Laing. From the stem of an unknown plant.

Although therefore this list almost doubles the number of 27 mentioned for Fiji by Laing, it is realized it is not exhaustive but it should serve none the less as a foundation for study of the local species of this most important family.

As is well known, most of these insects are attacked by the larvæ of lady-bird beetles and any elongate crawling insect, often brightly coloured, found in the vicinity of mealy bugs and scales should be spared.

Chemical control is best effected by means of white spraying oil obtainable at 1s. per pint or 1s. 8d. per quart at the Department of Agriculture or 6s. 6d. per gallon from one of the local merchants. This oil is a great improvement

on the somewhat cumbrous kerosene and soap emulsion and used at a strength of 1 to 40 of water is economical.

Acknowledgments for identification are made to the Director of the Imperial Institute of Entomology, London.

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(4) Ditto. 1924.—*Ibid.* Vol. 49, Part 2.
(5) Greenwood, W. 1929—*Ibid.* Vol. 54, Part 4.
(6) Ditto. 1940.—*Ibid.* Vol. 65, Parts 3-4.
(7) Nixon, G. E. J. 1942.—*Ann. and Mag. Nat. Hist.* Ser. 11, Vol. 9, June, pp. 462-464.
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(9) Simmonds, H. W. 1938.—Bull. No. 20, Department of Agriculture, Fiji.

AGRICULTURAL NOTES.

Rice.—The rice position again gives cause for concern to both consumers and growers.

Drought conditions prevailing at the normal planting season towards the end of last year compelled plantings to be made much later, even extending to early March of this year, with the result that yields will probably be below normal. To this must be added the fact that heavy rains in April and May caused a fair amount of lodging in some areas, while amongst cane-growers, owing to a greater concentration on sugar production to endeavour to retrieve losses incurred from 1943-44 onwards, a smaller area was planted to rice than was the case last year. In addition imports of rice from overseas are already seriously curtailed and it is doubtful if further supplies will be forthcoming this year.

In view of these facts, all consumers who have the land, especially estate owners, copra planters, etc., should at once endeavour to safeguard themselves and their labour by planting up sufficient native root crops, such as kumalas, tapioca, dalo, etc., to meet all anticipated requirements and thus assist in safeguarding the food requirements of the Colony.

Produce.—No serious storms were recorded during the early part of the year with the result that supplies of fresh produce for export to New Zealand showed an increase, in the case of bananas, of over 5,000 cases over the figures for the corresponding period, January-April of 1944.

The figures for March, April and May, 1945, are given below and, provided the supply of cases can be maintained to meet the quantities of fruit on offer, the export quantity for this year should show a very satisfactory increase over that of 1944.

Of particular interest were two consignments of avocado pears, made by this department, the fruit being produced at the General Experiment Station at Sigatoka. The first consignment forwarded in early March to New Zealand consisted of 22 cases, each case containing about $2\frac{1}{2}$ dozen pears, and realized the very satisfactory price of 22s. $9\frac{3}{4}$d. per case f.o.b. Suva. The second lot, forwarded at Easter and numbering 14 cases, was the last of the season and, suffering some delay in shipment, did not arrive in such good condition as the first lot, but nevertheless realized 7s. 2d. f.o.b. Suva.

From the foregoing it can be seen that avocado pears can be marketed in New Zealand in limited quantities at prices satisfactory to the producer. Care must, however, be taken in the wrapping and packing of the fruits, which it is necessary to harvest within two to three days of shipping to ensure that the quality will be satisfactory on arrival in the market.

The following are the figures for produce forwarded overseas during March, April and May, 1945 :—

To New Zealand.

	Bananas.	Copra.	Avocado Pears.	Coco-nuts.	Citrus.	Green Ginger.	Paw-paw.	Pine-apples.
	cases.	bags.	cases.	bags.	cases.	cwt.	cases.	cases.
March ..	12,872	....	....	....	44	3	2	2
April ..	2,648	3,252	36	200	18	3	3	....
May ..	7,106	375	....	....	140	22	....	....

To Military Hospitals Overseas.

	Bananas.	Water Melons.	Oranges.	Mandarins.	Grape fruit.	Pawpaw.
	cases.	cases.	cases.	cases.	cases.	cases.
March	450	72	215	135	41	37
April	106	..	101	432	..	12
May	217	..	25	225	..	..

Crop Pests.—Wild Pigs : Complaints have been received from time to time concerning depredations of wild pigs amongst food crops. Where Fijians are concerned the usual practice has been for the men of the community concerned periodically to organize pig hunts with dogs, and in this way reasonable control of this menace was exercised. With so many of the Fijians now serving in the armed forces this type of control has not been maintained, with the result that crop damage has been more extensive, particularly at a time when every pound of foodstuffs counts.

The Indian settlers of Vunikavikaloa, in the province of Ra, appealed to this department for assistance in controlling the wild pig menace, so an officer was detailed to investigate the matter and if possible recommend and/or organize practical control measures on the spot.

The officer concerned spent a week in the district during which time the presence of wild pigs was clearly noted by the wallows, crop destruction by rooting, etc.

Attempted control by poisoning being out of the question at the moment, the only practical method appeared to be the organizing of regular pig hunts. For this purpose two Indians and one Fijian pig hunter were organized with seven dogs, the Fijian being armed with a spear. This group accounted for one pig only. A second group, accompanied by the officer in charge who carried a service rifle, did not have any success although the presence of pigs was evident. This group found that under the conditions prevailing practically no use could be made of the rifle, the underbush being too dense. Subsequently several pigs were killed by the hunters.

The result of these endeavours has been to give the Indian settlers at Vunikavikaloa some confidence in themselves and in hunting as a method of control.

Finally the department has under active consideration the importation into the Colony from overseas of dogs of a type suitable for producing good pig hunters.

—H.R.S.

ENTOMOLOGICAL NOTES.

By
R. J. A. W. LEVER, B.Sc., D.I.C., A.I.C.T.A., F.L.S., Entomologist.

1. RECOVERY OF THE PARASITE *NEMERITIS* IN SOUTH TAVEUNI.

THE black and orange Ichneumon parasite *Nemeritis palmaris* Wilk. was introduced from Java to Fiji by Paine in 1933. From a stock of only 40, over 11,000 individuals were liberated, more than 6,000 of them on Taveuni (1).

In 1937 the writer on a short visit took this parasite in northern Taveuni at Mua (2) and this note is to record its rearing in March, 1945, from cocoons of the coconut spike moth, *Tirathaba trichogramma* Meyr., collected at Waimaqere in southern Taveuni. Paine suggested in his paper that it was likely to prove a useful parasite and this is borne out by this record, as only a handful of *Tirathaba* cocoons was collected while I was examining a felled palm for another purpose. The Tachinid fly, *Erycia basifulva* Bezzi, was also taken on this occasion, as was the case in 1937, and this fly is clearly also well established.

This shows that Paine's work in the East Indies did permanent good for Fiji in controlling the spike moth and confirms Corbett's suggestion (3) that *Nemeritis* " is an eminently suitable parasite for introducing (from Malaya) to another country ".

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(3) Corbett, G. H., 1930. Scientific Series, No. 3, Department of Agriculture S.S. and F.M.S. p. 7.

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2. LOCAL DISTRIBUTION OF THE MOSQUITO *AEDES SCUTELLARIS* WLK. *HORRESCENS* EDW.

ALTHOUGH Edwards' original description (1) of *Aëdes scutellaris* Wlk. *horrescens* Edw. gave Taveuni as the type locality he mentioned that Paine took the mosquito also at Nabavatu [Vanuabalavu], Lau. In his bulletin (2) Paine amplified this by listing Vanua Levu as well as the small islands of Gau, Nairai, Naigani and Naitauba. A year ago the writer recorded it in the Suva area (3), showing that Paine's suggestion to Edwards (1) that it is possible that this hairy variety does not occur in Viti Levu was incorrect.

In the most recent discussion on this subject Farner and Bohart (4), in a most valuable paper state that the variety *horrescens* is recorded only from Taveuni and mark its distribution as being confined to this one island though, as shown above, it occurs throughout the Colony and can be expected from Kadavu where no collections of it seem to have been made. Besides the water places given by Farner and Bohart, this variety has been taken in stumps of bamboo and tree-ferns as well as a tin, though tree-holes are clearly the most usual sites for egg laying.

It can be said that no instances of inter-insular specific variation among mosquitoes have been recorded for Fiji (exclusive of Rotuma).

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(2) Paine, R. W. 1935.—" An Introduction to the Mosquitoes of Fiji ". Suva. (Reprinted 1943).
(3) Lever, R. J. A. W. 1944.—*Agric. Jrnl.* Fiji. Vol. 15, No. 2, June, p. 47.
(4) Farner, D. S. and Bohart, R. M., 1945.—*Naval Medical Bull.* Vol. 44, No. 1, January, pages 42, 45 and 48.

3. CHECK LIST OF FIJI MOSQUITOES WITH FURTHER NOTES ON A NEWLY DESCRIBED SPECIES.

SINCE the occupation of various Pacific Islands by allied forces much more work has been done on the control, distribution, biology and systematics of mosquitoes than at any time previously. Consequently many older references have been found to be incorrect and many additions have had to be made to the mosquito fauna. Fiji is no exception and the following is a complete list of the known indigenous mosquitoes of the Colony with, it is believed, their accepted names at the moment. The year in brackets is the first recorded capture, not necessarily the year of description :—

1. *Tripteroides* (*Tripteroides*) *purpurata* Edw. (1911).
2. *T.* (*Mimeteomyia*) *rotumana* Edw. (Rotuma only, 1928).
3. *Uranotænia colocasiæ* Edw. (1927).
4. *U. painei* Edw. (1935).
5. *Mansonia* (*Coquellittidia*) *crassipes* van der Wulp.
6. *Aedomyia catasticta* Knab. (1943).
7. *Aëdes* (*Finlaya*) *kochi* Dönitz. (1910, as *Finlaya pœcilia* Theob.)
8. *A.* (*Stegomyia*) *ægypti* L.
9. *A.* (*S.*) *scutellaris* Wlk. *pseudoscutellaris* Theo. (1910).
10. *A.* (*S.*) *scutellaris* Wlk. *horrescens* Edw. (1935).
11. *A.* (*Aedimorphus*) *vexans* Meig.
12. *A.* (*Levua*) *geoskusea* Amos (*suvæ* Stone and Bohart). (1944).
13. *Culex albinervis* Edw. (1928).
14. *C. annulirostris* Skuse.
15. *C. sitiens* Wied.
16. *C. fatigans* Wied. (U.S. workers use *C. quinquefasciatus* Say).

It will be noticed that *Aëdes* (*Ochlerotatus*) *vigilax* Skuse taken only in 1940 and *Megarhinus splendens* Wied. introduced in 1931 from Java are not indigenous species.

The record of No. 12, *Aëdes* (*Levua*) *geoskusea*, is interesting if only on account of its having been overlooked for so long, doubtless owing to siphoning of water from its habitat (crab and mud-lobster holes) not having been done thoroughly until last year. The new subgenus is derived by Stone and Bohart from the Fijian word " levu " (meaning " great ") in the name Viti Levu Island.

Owing to an erroneous spelling in a locally-printed training manual (1) having appeared earlier than the description of this mosquito by two entomologists (2), their name (*suvæ* Stone and Bohart) has by the law of priority to be sunk in favour of *geoskusea* Amos. This mistake arose through using the word *geoskusea* as a species when it was intended to refer to the subgenus *Geoskusea*, but the International Rules of Zoological Nomenclature give precedence to the earliest published reference even if made in error.

It seems desirable to record here that the description of this mosquito in the aforementioned manual as " dull or grey black " is not shared either by Stone and Bohart or by the writer. The first two describe it as a dark species with dark brown head, dark orange-brown scutum and dark brown

legs, and this description is confirmed by the writer who, after examining specimens from both south-east and north-east Viti Levu, has not seen any which could possibly be called dull or grey black.

In dealing with this mosquito last year (3) the writer—who then referred to it as *Aëdes* (*Geoskusea*) sp. near *longipalpis* Edw.—suggested that further search will doubtless show it to be distributed throughout the coastal areas other than around Suva. This was verified in January, 1945, when it was found in holes of the small mangrove crab *Thalamita* (kuka) at Nanukuloa, Viti Levu Bay, Ra.

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(1) Amos, D. W. 1944.—" Mosquito Control Training Manual ", Suva, August 15th, page 32.
(2) Stone, A. and Bohart, R. M. 1944.—*Proc. Entom. Soc. Wash.* Vol. 46, No. 8, November, page 214.
(3) Lever, R. J. A. W. 1944.—*Agric. Journal,* Fiji. Vol. 15. No. 2, June, page 50.

Since writing the above a new record for the Colony has been taken, viz. *Mansonia* (*Coquellittidia*) *xanthogaster* Edw., previously recorded from the New Hebrides and north Australia.

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4. FURTHER NOTES ON THE MOSQUITO *AEDOMYIA CATASTICTA* KNAB.

In a previous issue (1) of the *Journal* the mosquito *Aedomyia catasticta* Knab. (referred to as *A. venustipes* Skuse) was recorded from the river Nadi, then the only locality from which it was known. Searches in the rivers Waimanu and Navua, also on Viti Levu, failed to take its larvæ but it was found in swampy ground on coastal localities in Taveuni and Vanua Levu (Buca Bay) in March, 1945.

Besides the addition of these two islands to its distribution—it was first recorded from Fiji in 1943—the interest of these records is that the water-places in which larvæ were taken were so very unlike the first locality which was along the edges of a river. However, the threadlike algæ, known in Fiji as " lumi ", a species of *Nitella* (2), were present and specimens in captivity were seen to spend much of their time feeding on these plants, coming to the surface of the water much more infrequently than members of the genera *Aëdes* or *Culex*. This is comparable with observations made in South Queensland where in the laboratory it came to the surface " only when dislodged from plant stems by violent shaking or stirring " (3).

In view of R. W. Paine's residence for some time on Taveuni his failure to take *Aedomyia* on this island is attributed to the secretive habit of the larva which makes its capture a matter of some difficulty, especially as larvæ of *Culex albinervis* Edw. are more abundantly found in the same locality, thereby tending to make one discontinue further dipping. The " filamentous green alga at edge of stream " where Paine recorded (4) *C. albinervis* on Taveuni is almost certainly the same *Nitella*.

The short, vertically-carried siphon, so unlike that of other Culicidæ, combines with the long body-hairs and bow-shaped antennæ to make this one of the outstanding mosquito larvæ in Fiji.

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5. CORRECTION OF NOMENCLATURE FOR A MALARIAL MOSQUITO OF MELANESIA.

THE common malarial mosquito of the New Hebrides and Solomon Islands has for years been referred to as *Anopheles* (*Myzomyia*) *punctulatus* Don. *moluccensis* Swell. and Swell de Graf. Although it prefers more permanent water for breeding than does the typical form *A.* (*M*). *punctulatus punctulatus* Don. yet it will oviposit in small artificial containers (tins, canoes, drums, etc.) which is not the case with the latter.

Last May two American entomologists found (1) from a forty years' old French publication that priority must be given to the name *A.* (*M*). *punctulatus farauti* Laveran certainly for material from the New Hebrides and probably from the Solomons and eastern New Guinea. Accordingly the subspecific name *moluccensis* first used in 1920 must be dropped. This discovery from an old periodical which had been overlooked by all systematic workers on mosquitoes is of great interest as *farauti* is an intermediary host of benign and malignant tertian and probably also a quartan malaria (3) which caused heavy invaliding of troops in both the New Hebrides and Solomon Islands.

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SCIENCE IN THE EMPIRE.

DR. W. G. Ogg (Director of the Rothamsted Experimental Station), speaking from the agricultural side, said they had had in the past a great deal of voluntary collaboration from Australia, New Zealand and Canada. He referred to the successful way in which sheep and cattle in Australia, New Zealand and the Highlands of Scotland had been dealt with by this collaboration, and to similar success in dealing with a virus which attacked the cocoa plantations of the natives of certain parts of West Africa. He was glad a well-merited tribute had been paid to the Imperial Agricultural Bureau under Sir David Chadwick. The Colonial Office was now offering Fellowships to attract young workers out to Africa particularly, but also to the Colonies in general, where they could spend two years studying the problems and giving their specialist help. There were many big problems to be solved; for instance, the soil resources of the Commonwealth.

GAMMEXANE INSECTICIDE.

A NEW insecticide, to be called gammexane, was explained by Dr. Roland Slade, of Imperial Chemical Industries, in a lecture before the Liverpool Branch of the Society of Chemical Industry. Gammexane has been proved by laboratory tests more toxic than any other insecticide examined, and Dr. Slade said there was every indication that a new and highly effective material had been found to fight that age-old pest, the locust. Its value to agriculture and in other directions would be inestimable.

United Empire, Vol. 36, No. 2, March/April, 1945.

AN AGRICULTURAL SURVEY OF INDIAN FARMERS IN NAVUA.

By
L. W. HARWOOD, H.D.A., Agricultural Officer.

THE information contained in this agricultural survey was collected during the period October 1st, 1943, to March 31st 1944. The objects of the survey were to obtain as much possible information about :—

(*a*) Size of farms in Navua,
(*b*) Systems of land tenure and their effect,
(*c*) Types of farming,
(*d*) Livestock statistics,
(*e*) Rice cultivation.

Historical Sketch.

The Fiji Sugar Company which commenced its activities in 1883 brought the forefathers of the present Indian farmers to Navua as indentured labourers to work on the plantation. Another sugar mill was in existence in the district during this period but was not in operation. Bananas also contributed to the wealth of the district, ships anchoring off Naitonitoni to pick up their cargoes. An attempt was also made to establish a coffee mill. In 1912 the Vancouver Sugar Company took over the interests of the Fiji Sugar Company but closed down some years later.

After the sugar company ceased operations Indian farmers became interested in rice growing. It is an interesting fact that rice growing has, whenever East Indians are concerned, invariably followed in the wake of sugar-cane cultivation. In Fiji marginal lands have always attracted rice farmers and in British Guiana, when it was decided to reduce sugar exports, a similar state of affairs existed.

European farmers became interested in dairying and the Fiji Pastoral Company was established, but at the time of writing, only one European farmer remains in addition to the company.

Land Tenure.

Three types of tenure exist in Navua ; freehold, annual and leasehold. Most of the farms have been held for many years and have been leased out to rice farmers on annual tenancies.

In the less thickly populated part of the district the freeholders are interested in dairying, growing rice only for their own requirements. In addition to the annual tenancies obtained from freeholders, Crown land at Toka Toka has been subdivided into three-acre blocks for rice growing and let as annual tenancies. All leases referred to in the following tables are native leases of 21 years duration. The abbreviations, AT, F, and L, represent respectively annual tenancy, freehold and leasehold.

System of Farming.

In Navua the majority of Indian farmers are almost entirely dependent on rice production for their cash income, particularly those with farms of less than 20 acres which comprise more than 90 per cent of the holdings in Navua. Other crops are grown but to a very limited extent. The only other source of income which the farmer may have is the Fiji Pastoral Company and the Navua Road Board which are the chief employers of labour in the district. It is felt that this almost complete reliance on rice as a money crop has greatly affected the agricultural economy of the district. Firstly the farmer, by reason, according to him, of his insecurity of tenure, grows two crops of rice per annum so that he may receive as much income as possible from his

farm. New Guinea is the most popular variety of rice in the district, not because of its palatability and milling qualities, but because it may be incorporated in a two-crop per annum routine. This system is peculiar to Navua and although there is some evidence of grass fallows on the larger farms, it is felt that it may have detrimental effects on the soil. Although there are no crop records to support this suggestion, farmers generally have complained of reduced yields in recent years. Because of a ready market the crop is sold as milled rice but in times of overproduction this system may have to be considerably modified.

Analysis of Tables.

Table I reveals that of 366 farms surveyed, 297 or 81.1 per cent were held as annual tenancies, and of these tenancies 56 or 18.8 per cent were subleased either from native leaseholds or other annual tenancies. In one case a farmer had again sublet his sublease. Whenever lands of this nature are sublet, the rent is invariably increased to the new tenant and in some cases an increase in the price of rice will result in an increase in rental.

The five freeholds constitute 1.4 per cent of the total farms, whilst 64 or 17.5 per cent are 21-year leaseholds. It will be noticed also that 90.7 per cent of the farms are less than 20 acres in area. The average farmer in the thickly settled parts of Navua may have three or four annual tenancies at different rentals from different sources.

An examination of Table II shows, as was to be expected, that the number of persons per farm increased on all types of tenure for farms up to 50 acres in area, but not proportionately as does the average area cultivated per holding. The area cultivated per head and uncultivated per holding increases with the size of farm for all tenures. Undue stress should not be placed on the figures in Class IV as most of these farmers are engaged in dairy farming and grow rice only for their own requirements.

The averages for all classes of farms show that the farm held under leasehold is more than twice the size of the average annual tenancy. Also the area cultivated per holding is greater but not proportionately, whilst the area uncultivated per leasehold is more than three times the figure for an annual tenancy. The average area cultivated per head is almost identical for all types of tenure. It would appear that .85 acre represents the area which can be cultivated per unit of population. This indicates that the annual tenancies in Class I are too small and, as there are 229 farms in this class, the fact is of considerable importance, particularly as the area cultivated is influenced not only by the size of the area but also by the livestock owned, rent paid and other similar factors.

In Table III the figures in Class IV are again not regarded as being significant. The average figure for the rental paid per holding, which is of course influenced by the size of the farm and tenure, is higher in leaseholds, whilst the rental paid per acre of rice planted increases with the size of farm and security of tenure. In annual tenancies the rental per acre and per head of population is appreciably higher, the former decreasing, in the main, with the size of the farm, and the latter increasing. In other words, the farmer pays considerably more rent for land of doubtful tenure than for leaseholds which give comparative security for 21 years.

This appears to be one of the main reasons for the two crops of rice per annum in Navua. It is felt that such a system of land tenure is not conducive to good cultural methods, and the agricultural prosperity of the district depends very considerably on security of tenure.

Livestock statistics are reviewed in Table IV. The percentage of farmers owning livestock on leased and freehold lands is, in the main, greater than on annual tenancies, whilst the average number of animals owned per family is again slightly more in the case of leased land as would be anticipated in view of the increased size of leaseholds.

As it is a rice area, an adequate supply of working bullocks exists, but a more pleasing feature is the fact that each farmer owns at least one cow and two dozen poultry.

More goats could be kept on lands of over 20 acres in area provided that suitable arrangements could be made for controlling them. The percentage of farmers owning horses is very low.

A comparison of the figures in Class I of Tables II and IV, suggests that the average farmer on annual tenancy has insufficient land, not only for cropping but also for the satisfactory maintenance of the livestock which he requires for his livelihood. The desire to maintain livestock obviously exists as there is increased interest with an increase in area and improvement in tenure.

One regrettable aspect of the maintenance of livestock is that no efforts are made to use the animal droppings. Efforts to interest farmers in this important matter have been of no avail, farmers on annual tenancies advancing their insecurity of tenure as a reason for their failure to make use of the farmyard manure.

Table V deals with the figures for that portion of the 1944 rice crop grown during the period October 1st, 1943, to March 31st, 1944. It should be noted that, as two crops are grown each season, the figures given do not represent the total annual rice plantings, but the bulk of the 1944 crop has been covered in the table. The majority of the rice farmers are in Class I. The area planted per holding increases with the size of the farm but not proportionately. The area planted per head varies from .4 acre to one acre but the average figure of slightly over half an acre appears to be usual for the district. In farms of up to 20 acres in area, the percentage of cultivable land planted with rice is higher than in larger farms. To plant the Navua rice crop of 1,460 acres, almost 50 tons of seed was required, an average of 74 lb. per acre, which is obviously excessive.

In Malaya and India the average seeding rate is approximately 35 lb. per acre and even in those countries there is wastage. The heavy seeding rate is influenced, apart from carelessness, by poor preparation of seed beds, viability of seeds, and herd damage. It is felt that the question of improving seed bed management would perhaps justify investigation.

In Table VI the facts obtained from the preceding tables are summarized and indicate that the farmer on annual tenancy suffers in comparison with his more secure neighbour.

Table VII shows the acreage of crops, other than rice, grown in the district. The areas involved were too small to average out for each class and tenure. The figures indicate that there is considerable room for diversification of crops. The absence of permanent crops is deplored. Many farmers have been interviewed and again mentioned their insecurity of tenure as the reason for their reliance on one crop.

In conclusion it is pointed out that this survey cannot be completed until full statistics for the 1944 rice crop are available, when it is hoped to find the cost of production per ton of padi and to deal with such subjects as other sources of revenue, rice mills and milling, marketing of rice, and the capital value of farms in each class.

TABLE I—SIZE OF FARM IN NAVUA DISTRICT.

(Number, Size, Distribution and Type of Tenure.)

Sub-District.	Total number of farms.			Total farms.	Class I: up to 10 acres.			Class II: 10·1 to 20 acres.			Class III: 20·1 to 50 acres.			Class IV: over 50 acres.		
	AT	F.	L.		AT	F.	L.	AT	F.	L.	AT	F.	L.	AT	F.	L.
Toko Toko, Naitonitoni	178	..	..	178	150	..	..	23	..	..	5	..	..	..	..	..
Calia, Yunimako.	39	..	4	43	27	..	..	5	..	..	7	..	1	..	..	3
Waidova, Yakaboles	48	2	55	105	35	..	42	12	1	9	1	..	4	..	1	..
Qaraniqo, Vunaniu	32	3	5	40	17	..	1	10	..	..	3	..	1	2	3	3
Total	297	5	64	366	229	..	43	50	1	9	16	..	6	2	4	6

TABLE II—ACREAGE CULTIVATED.

	Average number of persons on holding.			Average size of holding in acres.			Average areas cultivated (acres).			Average area cultivated per head (acres).			Average area uncultivated per holding (acres).		
	AT	F.	L.	AT	F.	L.	AT	F.	L.	AT	F.	L.	AT	F.	L.
Averages for Class I	5·8	..	6·4	5·4	..	5·5	4·2	..	4·1	·72	..	·63	1·2	..	1·4
Averages for Class II	9·7	16·0	11·9	13·6	20·0	13·4	9·5	10·0	9·8	·98	·63	·83	4·1	10·0	3·6
Averages for Class III	8·8	..	16·0	27·8	..	26·1	12·8	..	12·4	1·45	..	·75	15·0	..	13·9
Averages for Class IV	2·5	9·5	9·3	172·0	172·1	120·1	8·5	9·3	25·0	3·4	·97	2·68	163·5	162·8	95·1
Averages for all Classes	6·60	10·8	8·97	9·1	141·7	19·3	5·6	9·4	7·6	·84	·87	·85	3·5	132·3	11·7

TABLE III—RENTALS.

Averages for each Class.

	Class I.						Class II.						Class III.						Class IV*					
	AT			L			AT			L			AT			L			AT			L		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
(*a*) Average rental per holding . ..	3	18	8	3	14	2	10	5	10	6	8	6	18	13	6	11	11	11	37	8	9	33	7	1
(*b*) Average rental per acre	0	14	8	0	12	9	0	15	1	0	9	7	0	13	5	0	8	11	0	4	4	0	5	7
(*c*) Average rental per head in family ..	0	13	7	0	11	7	1	1	2	0	10	10	2	2	5	0	14	6	14	19	6	3	11	6
(*d*) Average rental per acre of rice ..	1	5	2	1	2	6	1	11	0	1	8	11	2	11	9	1	13	2	18	14	5	3	9	9

* In view of the small number of samples in Class IV the results are not regarded as being significant.

Averages for all Classes.

(*a*) AT = £6 0 4
L = £7 12 2

(*b*) AT = £0 14 9
L = £0 7 11

(*c*) AT = £0 18 3
L = £0 17 0

(*d*) AT = £1 11 0
L = £1 15 4

TABLE IV—LIVESTOCK.

	Bullocks.			Cows.			Horses.			Poultry.			Goats.		
	AT	F	L	AT	F	L	AT	F	L	AT	F	L	AT	F	L
Average Percentage—Class I—															
Percentage owning livestock ..	65·1	..	73·8	44·5	..	54·8	5·9	..	..	83·8	..	90·7	12·2	..	11·9
Average number per family ..	1·37	..	1·28	·71	..	·65	·02	..	..	19·23	..	19·1	·48	..	·19
Average Percentage—Class II—															
Percentage owning livestock ..	96	100	100	92	100	100	20	100	11·1	98	100	100	38	100	33·3
Average number per family ..	2·36	3	2·44	1·9	2	·22	·18	2	·22	27·6	6	29·33	·92	4	2
Average Percentage—Class III—															
Percentage owning livestock ..	100	..	83·3	83·3	..	83·3	25	..	..	100	..	83·3	43·7	..	18·7
Average number per family ..	3·81	..	4·13	3·18	..	4·13	·5	..	...	39·75	..	23·0	2·81	..	1·83
Average Percentage—Class IV—															
Percentage owning livestock ..	50	100	100	50	100	100	100	50	100	100	100	100	50	75	33·3
Average number per family ..	2	5	5·33	30	45·5	46·66	1	2·75	1·83	30	37·5	45	6	9	5
Total for all Classes—															
Percentage owning livestock ..	72·3	100	79·7	55·2	100	67·2	5·7	60	10·9	87·2	100	92·2	18·5	80	20·3
Average number per family ..	1·67	4·6	2·09	1·25	36·4	5·45	·08	2·6	·19	21·8	31·2	23·3	·74	8·0	·92

TABLE V—RICE PLANTING AVERAGES FOR CLASSES IN EACH SUB-DISTRICT.

	Area planted in each district. (acres.)			Area planted per holding. (acres.)			Area planted per head. (acres.)			Percentage of cultivable land under rice.			Seed used per district. lb.			Seed used per acre.		
	AT	F	L	AT	F	L	AT	F	L	AT	F	L	AT	F	L	AT	F	L
Totals and averages for Class I	702·5	....	141·5	3·07	....	3·29	·57	..	·51	73·6	...	81·2	55,836	....	9,648	79·5	...	68·2
Totals and averages for Class II	332·2	10·0	40·0	6·64	10·0	4·44	·68	·63	·37	71·1	100	45·2	24,156	504	4,032	72·7	50·4	100·8
Totals and averages for Class III	115·5	...	36·0	7·22	...	6·0	·75	...	·43	52·8	...	48·5	6,996	....	3,240	60·6	...	90
Totals and averages for Class IV	4·0	20·0	58·0	2·0	5·0	9·66	·80	·52	1·03	23·5	54·1	38·7	264	1,416	4,272	61·0	70·8	73·6
Totals and averages for All Classes	1154·2	30·0	275·5	3·88	6·0	4·30	·62	·55	·53	69·6	63·8	56·6	87,252	1,920	21,192	75·6	64·0	76·9

TABLE VI.—SUMMARY OF AVERAGES.

	AT	F	L
Number of farms	297	5	64
Number of persons on holding	6·60	10·8	8·97
Size of holding (acres)	9·1	141·7	19·3
Area cultivated per holding	5·6	9·4	7·6
Area cultivated per head	·84	·87	·85
Rental per holding	£6 0 4	....	£7 12 2
Rental per acre	£0 14 9	....	£0 7 11
Rental per head	£0 18 3	....	£0 17 0
Rental per acre of rice	£1 11 0	....	£1 15 4
Percentage of farmers owning bullocks	72·3	100	79·7
Percentage of farmers owning cows	55·2	100	67·2
Percentage of farmers owning horses	5·7	60	10·9
Percentage of farmers owning poultry	87·2	100	92·2
Percentage of farmers owning goats	18·5	80	20·3
Number of bullocks per family	1·67	4·6	2·09
Number of cows per family	1·25	36·4	5·45
Number of horses per family	·08	2·6	·19
Number of poultry per family	21·8	31·2	33·3
Number of goats per family	·74	8·0	·92
Rice planted per district (acres)	1154·2	30·0	275·5
Rice planted per holding (acres)	3·88	6·0	4·30
Rice planted per head (acres)	·62	·55	·53
Percentage of cultivated land under rice	69·6	63·8	56·6
Padi Seed used per district (lb)	87,252	1,920	21,192
Padi Seed used per acre (lb)	75·6	64·0	76·9

TABLE VII—OTHER CROPS.

Name of crop.	Number of farmers.	Area in acres.	Average area.	Number of trees.	Average number of trees per farm.
Maize	366	42·6	·12	....	....
Cowpea	,,	58·4	·16	....	....
Mungh	,,	32·1	·09	....	....
Vegetables	,,	54·9	·15	....	....
Coconuts	,,	....	....	252	·69
Breadfruit	,,	....	....	55	·15
Bananas	,,	....	....	294	·80
Mandarins	,,	....	....	60	·16
Oranges	,,	....	....	104	·28
Custard Apples	,,	....	....	66	·18
	366	·51	....	83·1	2·2

EXTRACTS.

PASTURE TYPES AND MANAGEMENT.

By C. R. TURBET.

DURING the development of the pastoral industry in Fiji and, more recently, since the development of dairying, much information of a practical kind has been gained in regard to pasture management. There are many dairy farmers and stock raisers who do little towards the improvement of their pastures and even on the better managed properties much remains to be done. The need for more thought and greater effort in pasture improvement is stressed in order that animal production and dairying in particular in this country may be brought up to the full productive capacity of the land.

The importation and introduction of most of the well-known pastoral plants of temperate countries have been attempted but with little success. With the exception of *Paspalum dilatatum* and couch grass, *Cynodon dactylon*, imported grasses from such regions have not thrived, and it is necessary to turn to other tropical zones to obtain pasture plants suitable to the climatic conditions of Fiji. Whereas considerable expense has been incurred and care exercised in attempts to introduce plants of temperate zones, many of the existing pasture plants have been accidentally introduced by the immigration of people or by mixture amongst seeds of vegetables and other introduced plants. The deliberate introduction of para grass (*Brachiaria mutica*) is an exception.

Any attempt to improve pastures should be preceded by a well-planned fencing programme. Good fences are necessary to control the grazing of the pastures. Where grassland is already in existence, its improvement should be carried out in the following order :—the elimination of weeds, drainage and the improvement of fertility status. It is considered that the eradication of weeds and the consequent encouragement of uniform grazing is a most important operation in effecting improvement. In this connexion much greater use should be made of some form of grasscutting machine.

The dairying lands in the Colony require more drainage and better control in the maintenance of drains. When the pasture has been improved by the elimination of weeds and by draining, considerable improvement of the nutritive qualities of the pasture is to be expected from the judicious use of artificial fertilizers or of farmyard manure.

Most soils are deficient in lime, and dressing with one of the more easily available forms of lime is advantageous. Interest seems to be awakening to this fact, and it is hoped that in the near future agricultural lime will be available at a reasonable cost. Coral sand is useful (90-95 per cent calcium carbonate) and is occasionally applied.

In the wet zone of Fiji there are two types of dairy farm land, alluvial river flats and hill land. In the former type free use of the plough is indicated, while in the latter, owing to the risk of soil erosion, the use of ploughing is hazardous. In bringing about rapid improvement of the pastures on tillable land, ploughing should be adopted after the erection of fences and construction of drains. Cultivation should be done after light to moderate rains. A fair proportion, at least, of the available pasture land should be put down to para grass. This grass may be established in newly ploughed land by laying cut stalks in the furrows so that a portion of the stalks will not be covered by the turnover of the next furrow. Unless such a field is cross-harrowed, it will be found uncomfortable to the cattle and the field workers owing to the rough surface of the ground. Harrowing should, therefore, be done in the early stages.

Some cultivation of alluvial flat pasture land should take place on each farm annually. If a para field has been in use for several years and subjected to considerable grazing, it will be found that other plants occur more and more frequently in the field, until the sward becomes very mixed. This may be considered as more or less desirable, provided that new fields are prepared and laid down to para in rotation.

It may be well at this stage to give details of a scheme for the control of grazing on dairy farms where the fields consist of para alone in some fields and mixed herbage in others. There is no doubt as to the high value of young para grass as a principal feed for dairy cattle and every effort should be made to obtain the greatest benefit from these fields, and at the same time to conserve their usefulness. Much damage is done to para grass by allowing cattle to remain too long in the fields so that much of the para is destroyed by excessive tramping and by cattle lying down after feeding. It has been found a good plan to place the cattle immediately after the morning's milking in the para field to be grazed. Cattle will feed eagerly at this period. They should be carefully observed and when it is seen that they have eaten their fill and are commencing to lie down, they should be driven out of the para field into one of short pasture, preferably where shade is provided and on a river bank if possible. The time of this first grazing may be as long as two hours. The same procedure may be adopted following the afternoon milking, after which the cattle are again moved to short pasture for the night.

As is to be expected, there is considerable variation in the average composition of pastures according to rainfall and temperature differences due to geographical location. There is also much poor pasture due, not only to poorness of soil conditions, but also to heavy weed growth even when the soil is good, and to gross overstocking, especially in the dry zones.

One seldom observes pure stands of any grass. Such do occur, however, in the wet zone in the case of para grass (*Brachiaria mutica*) and Guinea grass, (*Panicum maximum*), which are lightly stocked or not stocked at all. Grasses of the blue grass family, *Dichanthium* species, are becoming more prominent and small fields of pure stands are to be seen in the vicinity of Suva. In the dry zone the best example of a practically pure stand is Caboni grass, *Amphilophis glabra*, where it occurs on the northern coast of Viti Levu.

In most pastures a particular grass or forage plant will be found to be dominant ; nevertheless, many other species of grasses and weeds may be found in the same field. Among the dominant species found may be mentioned *Paspalum dilatatum*, Guinea grass, carpet grass (*Axonopus affinis*), Thurston, or Sour grass (*Trichachne insularis*), *Paspalum conjugatum* ; the sensitive plant, *Mimosa pudica*; love or seed grass, *Chrysopogon aciculatus*; blue grasses (Nadi or Nawai or Mololo grass) *Dichanthium* species, and Caboni grass, *Amphilophis glabra*. One should not fail to mention also the " reed grass," *Miscanthus japonica*, which is indigenous to Fiji and which covers all lands not forested provided it is not interfered with by man or animals through firing, cutting or grazing.

The less prominent species composing the pasture are also important since they help to balance the diet. Of considerable value in this respect are the so-called Fiji trefoils—members of the genus *Desmodium* of which four species occur, namely, *D. triflorum*, *D. heterophyllum*, *D. heterocarpum* and *D. polycarpum*. These plants, together with the sensitive plant, take the place of the clovers and trefoils of temperate lands. —H.T.B.H.

—*Provision of Animal Fodder in Tropical and Subtropical Countries*, Pt. I, Bulletin 31 of Imperial Bureau of Pastures and Forage Crops, Wales, August, 1944.

WRITE SIMPLY.

As it was written :—The optimum conditions for the storage of seed are obtained when both temperature and humidity are maintained at a low and constant level. *Try* :—Constant cool and dry conditions are the best for storing seed.

As it was written :—The successful storage of seed is dependent on moisture-content before storage being reduced to a sufficiently low value. *Try* :—Seed must be well dried before it can be successfully stored.

As it was written :—Their increased height adds to their conspicuousness, both auditory and visual. *Try* :—Their increased height makes them easier to hear and to see.

As it was written :—The arrangement functioned well. *Try* :—The arrangement worked well.

As it was written :—A prolonged spell of drought conditions. *Try* :—A long dry spell.

As it was written :—So that access may be effected to the building with the minimum of delay. *Try* :—So that the building may be entered with the least delay.

As it was written :—It seems not unlikely that the immediate difficulties may become so great that it will be impossible to continue to place reliance on supplies from overseas. *Try* :—Difficulties may become so great that supplies from overseas can no longer be relied upon.

—*East African Agricultural Journal*, Vol. 10, No. 3, January, 1945.

TREE NUTRITION.

THERE is considerable evidence that the healthy growth of trees such as pines and spruces is intimately bound up with an association between their roots and fungi present in woodland soil. Poverty in mineral nutrients is no longer regarded as a necessarily critical factor in the failure of growth of trees of this kind, since the associated fungi have at their disposal sources of supply inaccessible to the roots of higher plants.

Experiments carried out during the past ten years at Wareham in England fully confirm the opinion, expressed long ago by Melin, that the growth of trees and other plants on poor soils of the raw humus type is greatly influenced by the root-fungus association. By fostering the appropriate combination it has been possible to carry out successful afforestation of heathland so poor that ordinary cultural methods prove inadequate for even the least exacting tree species. Satisfying the mineral requirements of the trees by direct application of fertilizers is not in itself sufficient treatment to ensure continued healthy growth ; biological factors also play an essential role in promoting soil fertility. The experiments have shown that failure of the trees to establish a satisfactory biological equilibrium with the necessary fungi is commonly due, not to the absence of these fungi in the soil, but to their inactivation by toxic products of biological origin. The factors inhibiting the activity of the fungi can be removed by the application of comparatively small amounts of special composts which produce dramatic and lasting effects on the growth of roots and shoots.

The special composts used are prepared from organic materials such as straw, hop waste and sawdust. The mechanism by which they stimulate growth is still obscure. All of them contain small amounts of directly available plant foods such as phosphates and potash, but careful investigation, both in laboratory pot cultures and in the field, has shown that these can account for only a relatively temporary effect on growth. It is suggested that the composts act mainly by modifying the course of humus decomposition, thus bringing about drastic changes in the biological activities of the organic substrate of the soil.

This demonstration of the profound influence of biological factors on the nutrition of trees challenges the attention of foresters and has important practical applications. By making use of suitable composts it will be possible to carry out the successful afforestation of land formerly regarded as wholly unproductive.

—*Monthly Science News*, No. 43, February, 1945.

The information set out above is a further practical demonstration of the value of compost in the successful production of various crops of economic importance whether in the garden or in the field. —H.R.S.

SEAWEED GIVES BRITAIN KEY WAR MATERIAL.

WHENEVER you eat ice cream, jelly or custard, apply a salve to a burn, go into hospital for an operation, or call a welder to mend a leaking petrol tank or radiator, you are probably making use of one of Britain's newest and least-known war materials—seaweed.

Two years ago *The Daily Telegraph* exclusively related how the Ministry of Supply had dispatched a party of scientists round the coasts of Britain. Their task was to survey the extent of the seaweed "crop."

Now it is possible to disclose what has hitherto been a war secret: That the collection and processing of seaweed has grown almost to the dimensions of a national industry. And it is still growing.

One firm alone in the Home Counties uses between 15,000 and 20,000 tons of seaweed every year, most of which is imported from Eire. Much more is still needed. The Scottish Industrial Council, with the support of the Scottish Office, is now trying to achieve a big expansion of collection.

The seaweed that is in bulk demand is the common type. From it is extracted calcium alignate, a gelatinous substance closely allied to cellulose. A bewildering variety of articles can be made from it.

Calcium alignate goes into various kinds of foodstuffs. It makes surgical materials, non-inflammable or soluble textiles, and medicines.

Use in Making Dried Blood.

It is used to make capsules of all kinds, and is employed in the preparation of dried blood. In another form it is extensively used in brain and eye surgery. It is also used in the manufacture of paint and plastics.

This new industry is the result of the work of British scientists. It had a pre-war beginning, but its rapid development followed the entry of Japan into the war.

Previously, this country [England] imported from Japan every year hundreds of tons of agar-agar, a gelatinous substance of great importance to scientific work as the medium for bacteria culture. It also has great medicinal value.

During their survey in 1942 the scientific party discovered two types of red seaweed round British shores from which agar-agar could be produced. Under the ægis of the Ministry of Supply, a widespread collection has been organized.

Unlike the collection of the common seaweed, which provides occupation for crofters during the winter, the harvesting of the red seaweed is confined to the summer. During the coming months parties of Boy Scouts, Girl Guides, W.V.S. and other volunteers will comb the beaches for the inconspicuous sea plant which contains the precious substance.

Each party will be led by an expert who can differentiate between the useful and unwanted types.

—*Daily Telegraph and Morning Post*, March 13, 1945.

INSECT CONTROL BY BATTERY.

ONE of the serious maize pests in the U.S.A. is the European corn borer (*Pyrausta nubilalis*) against which many parasites have been introduced and various agricultural methods practised.

A recent review of a paper in *Agricultural Engineering* claims effective control by the novel method of hammering the stalks so as to kill the enclosed caterpillars of which 94 to 97 per cent were crushed to death by a combination of pulverizing and hammering, the machine being power-driven. —R.J.A.W.L.

ERRATA—Vol. 16, No. 1, March, 1945.

Page 4, penultimate paragraph, for " Ji " read gi.
Page 8, paragraph 4, line 4, for " *Cataroma* " read *Catorama*.
Page 9, " Host Plants," last line but one, for " *B. sativus hortensis* " read *Raphanus sativus hortensis*.
Page 10, Note 3, line 2 for " Peteromalid " read Pteromalid.
Page 10, Note 3, line 4 for " cam " read Cam.
Page 10, Note 3, line 6 for " *pinnato* " read *pinnata*.
Page 11, line 7 for " Cheerman " read Cheesman.
Page 28, line 2 for " *pudicans* " read *pudica*.

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Index for 1944 headed Vol. 14 should be Volume 15.